

DENTAL VIDEO CAMERA

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 6 Serial No. 08/560,397, now U. S. Patent No. 5,771,067, which
 7 is a continuation-in-part of the application filed on April
 8 20, 1995 under Serial No. 08/426,119, now U. S. Patent No.
 9 5,737,013, which is a continuation-in-part of the
 10 application filed on September 8, 1994 under Serial No.
 11 08/303,019, now U. S. Patent No. 5,523,782, which is a
 12 continuation-in-part of the application filed on September
 13 11, 1992 under Serial No. 07/943,716.

14 BACKGROUND OF THE INVENTION

15 The field of the invention is dental video cameras.

1 U. S. Patent No. 6,190,309 teaches a video scope that
2 has an entry section which can advance into an object; and a
3 grip section which is disposed at the back of the entry
4 section and to be held by an operator. The video scope
5 includes a light-reflecting body, an objective-lens, a
6 solid-state image-pickup device, a light source, a window of
7 incidence for image pickup rays and illumination windows
8 that are located in the vicinities of the window of
9 incidence. A power source is disposed in the grip section
10 for driving the light source. A portable accommodation case
11 has an accommodation space for accommodating the video
12 scope. A lid has a thin display attached thereto and can
13 rotate freely and stop at an optional position. The thin
14 display is capable of displaying an image that is picked up
15 by the video scope.

16 U. S. Patent No. 5,908,294 teaches a hand-held dental
17 video camera which includes a window for receiving light. In
18 some aspects of the invention, a lamp is mounted distally

1 beyond the window and aimed to illuminate a subject. A
2 white light emitting diode is used to illuminate the
3 subject.

4 U. S. Patent No. 5,523,782 teaches a video dental
5 camera that includes a light source, a charge coupled device
6 and an adjustable focus lens system. Other examples of
7 existing system can be found in U. S. Patent No. 4,575,805
8 and U. S. Patent No. 5,527,261. Until now, however, it has
9 been extremely difficult to fashion a sufficiently slim
10 instrument. Slim instruments are desirable because they
11 provide accessibility to places that thicker instruments can
12 not reach. Moreover, even in cases where a thick instrument
13 can provide adequate access, the slimmer instruments can
14 reduce the discomfort experienced by the patient. One
15 factor contributing to the thickness of previous dental
16 video cameras is the type of light source that is
17 incorporated into the camera head.

18 U. S. Patent No. 5,429,502 teaches a dental camera that

1 uses an external light source and route the light from the
 2 source to the head using fiber optics. In this arrangement
 3 the optical fibers travel through the cable and through the
 4 body of the handheld camera unit thereby resulting in a
 5 stiffer cable reducing maneuverability and a thicker
 6 handheld unit. The fiber optic connections require a
 7 complex and expensive connector as compared to fully
 8 electrical connectors. Using fiber optics to illuminate the
 9 subject requires increased power because some of the light
 10 energy is lost in the optical fiber.

11 There are imaging devices that use lamps at the end of
 12 the imaging head instead of fiber optics. These lamps have
 13 not been used in configurations that minimize the thickness
 14 of the instrument. The lamps in the dental camera of U. S.
 15 Patent No. 5,523,782 are positioned axially away from the
 16 imaging window. The lamp in the dental camera of U. S.
 17 Patent No. 4,575,805 is positioned on the proximal side of
 18 the imaging window. Both of these configurations result in

1 relatively thick instruments. In addition, the lamps used
2 in previous imaging devices had significant shortcomings. A
3 halogen lamp that is used in the dental camera of U. S.
4 Patent No. 5,527,261 consumes significant power and
5 generates heat. The lighting emitting device (LED) that are
6 used The lamp in the dental camera of U. S. Patent No.
7 4,575,805, like all ordinary light emitting diodes, produces
8 essentially monochromatic light that can make diagnosis of
9 certain medical conditions difficult.

10 U. S. Patent No. 5,124,797 teaches a video-imaging
11 camera that has a detachable distal module that is
12 replaceable with one of different characteristics and
13 sterilizable. A non-replaceable charge coupled device and a
14 video transmitter are connected to an inner body that
15 includes a lens tube. The module includes an outer body
16 encasing the inner body. The inner body may have a filter
17 at its tip and a magnifying lens optically connected to an
18 image conduit optical segment. The inner body receives an

1 image conduit. The lens focuses the output of the image
 2 conduit and is disposed in the inner body on a charge
 3 coupled device microprocessor. The model may be replaced
 4 with an angular distal end or lenses of different fields of
 5 view. Fiber optic light filaments may be used to illuminate
 6 the field of view of the tip of the module, either housed
 7 internally or externally of the inner body.

8 U. S. Patent No. 4,300,167 teaches an automatic iris
 9 control system which connected between a video camera and
 10 optical input device which produces an optical image from a
 11 light directed upon and reflected from a subject. The
 12 optical image is directed onto the surface of an electronic
 13 imaging tube in the video camera. The optical image has a
 14 wide variation of reflected light due to variations in
 15 distance of the subject from the light source. The
 16 automatic iris control system has an adjustable iris and a
 17 drive motor. The drive motor is located between the surface
 18 of the electronic imaging tube. An optical input device

1 dynamically varies the intensity of the optical image
2 applied to the electronic imaging tube of the video camera.
3 A light intensity programming circuit establishes a desired
4 light intensity level on the surface of the electronic
5 imaging tube of the video camera and an automatic iris
6 control circuit. The automatic iris control circuit has a
7 low gain amplifier, a weighted peak response detector, a
8 comparator and a circuit. The circuit controls the current
9 to the iris drive motor and a circuit for providing a
10 feedback signal representing the direction in which the iris
11 must be adjusted by the motor to control the light intensity
12 on the surface of the electronic imaging tube of the video
13 camera is shown.

14 U. S. Patent No. 5,047,847 teaches a liquid crystal
15 assembly. The assembly forms at least a part of an image
16 optical system. The assembly includes a plurality of liquid
17 crystals. The liquid crystal have a refractive index
18 anisotropy and different response frequencies of molecule

1 orientation so that the transitivity and refractive index of
2 the plurality of liquid crystals may be independently
3 controlled with few signal lines by varying the frequency of
4 the driving signal applied to the liquid crystal assembly.

5 U. S. Patent No. 5,296,944 teaches an image scanner.

6 The image scanner includes a light source that illuminates
7 an original document, an image sensor that receives a
8 reflected light from the original document and converts the
9 same into an output signal of image data, a device that
10 relatively moves the original document and the image sensor,
11 an iris mechanism that is provided on an optical path
12 between the original document and the image sensor, a
13 reference reflection plane that is provided such that a
14 light from the light source is reflected and the reflection
15 light becomes incident on the image sensor, a comparing
16 circuit that compares a level of an output signal from the
17 image sensor with a reference level when the image sensor
18 receives the light from the reference reflection plane and a

1 device for correcting a dynamic range of the image scanner
2 by controlling the iris mechanism on the basis of the
3 compared output.

4 U. S. Patent No. 5,124,797 teaches a dental video
5 camera. The dental video camera includes a proximal housing
6 and a distal module consists of a body containing a
7 magnifying lens, a filter and an optical fiber image
8 conduit. The distal module is sterilizable. The proximal
9 housing which is unable to withstand autoclaving does not
10 require sterilization since it does not contact the patient.

11 U. S. Patent No. 4,919,114 teaches an endoscope. The
12 endoscope includes a solid state imaging device and a
13 flexible insertable part for insertion into a body cavity.
14 The solid-state imaging device obtains an optical image of
15 an observed part through an observing window provided in a
16 tip part of the flexible insertable part.

17 U. S. Patent No. 4,858,001 teaches a hand held
18 endoscopic apparatus which consists of a body, a camera and

1 a removable and interchangeable objective element which is
2 capable of presenting an image of an object to the camera.
3 An optically transparent sheath is capable of isolating the
4 endoscope from the working environment.

5 U. S. Patent No. 4,727,416 teaches a video dental
6 camera which includes a handle, a camera head and a mirror.
7 The camera head is located at the distal end of the handle
8 with the camera head being disposed at an angle to the
9 handle.

10 U. S. Patent No. 4,757,381 teaches sheaths which are
11 dispensed on a perforated role. Each sheath prevents a
12 dental camera from coming into contact with the patient,
13 while allowing the dental camera to function properly.

14 U. S. Patent No. 4,914,521 teaches a sterilizable video
15 camera cover. The cover has a connector and a receptacle.
16 The connector has a guide-way for receiving a video camera
17 within a predetermined fixed orientation and serves as a
18 bacteria barrier. The receptacle holds the video camera

1 against a window at the distal end of the connector.

2 U. S. Patent No. 4,915,626 teaches a dental video
3 camera which is used to view an image of the interior of the
4 mouth of a patient. The dental video camera displays
5 contemporaneously a video image of the interior of the
6 mouth.

7 U. S. Patent No. 4,589,404 teaches a laser endoscope.
8 The laser endoscope includes a video camera and an optical
9 system. The video camera transmits an image through the
10 optical system.

11 U. S. Patent No. 4,600,939 and U. S. Patent No.
12 4,639,772 teach a highly compact focusable video camera
13 which includes an optical system, a sensor-converter and
14 a video electronic processing circuit. The sensor-converter
15 receives an optical image passing through the optical system
16 and converts the optical image to an unprocessed video
17 signal. The video electronic processing circuit processes
18 the unprocessed video signal.

1 U. S. Patent No. 4,837,615 teaches a hand held optical
2 probe. The probe includes a light source, two bundles of
3 optical fibers for directing light axially into a fastener
4 hole. The tip end of each bundle being directed at a right
5 angle to the axis of the fastener hole so that the panel
6 edges are illuminated.

7 U. S. Patent No. 5,604,531 teaches an in vivo video
8 camera system which includes a swallowable capsule, a
9 transmitter, a light emitting diode and a reception system.

10 The swallowable capsule includes a camera system and an
11 optical system for imaging an area of interest onto the
12 camera system. The transmitter transmits the video output
13 of the camera system and the reception system receives the
14 transmitted video output.

15 U. S. Patent No. 5,527,261 teaches a hand-held, fully
16 remote diagnostic instrument having video capability which
17 is configured for any one of a number of clinical or
18 industrial applications. The instrument has a casing that

1 includes a hand-holdable body portion, a neck portion that
2 extends from the body portion to a head portion that is
3 formed of a back cover, a front cover, and a sealing gasket
4 to form a fully soakable instrument. A circuit board
5 assembly in the body portion contains video processing
6 circuitry and a flexible neck board. The neck board extends
7 forward from the body portion through the neck portion of
8 the casing to a headboard located in the head portion of the
9 casing. A solid state imager and a miniature lamp are
10 disposed on the headboard. The front cover contains an
11 adjustable focus lens cell for focusing on the imager an
12 image of a target in the lens cell's field of view. The
13 instrument can be configured for various applications by
14 installing front and back covers that are suited for a
15 specific purpose. The instrument can thus be used as a
16 dental camera. The instrument provides a monitor-ready,
17 standard format, full color video signal to a remotely
18 located monitor.

1 SUMMARY OF INVENTION

2 The present invention is generally directed to a dental
3 video camera. The dental video camera includes a housing,
4 an adjustably focusing lens and a charge coupled device
5 camera system. The adjustably focusing lens, the charge
6 coupled device camera system and the fixed focusing lens
7 system are all disposed in the housing.

8 In a first aspect of the present invention, the dental
9 video camera includes an electrically adjustable iris that
10 is optically coupled to the adjustably focusing lens system.

11 The adjustably focusing lens provides a focusing
12 adjustment between a near field of focus and a far field of
13 focus. The electrically adjustable iris is adjusted between
14 a nearly closed opening and a wide open opening in response
15 to the focusing adjustment between the near field
16 of focus and the far field of focus.

17 In a second aspect of the present invention, the dental
18 video camera includes a light source that is disposed in the

1 elongated cavity of the housing.

2 In a third aspect of the present invention, the light
3 source is at least one lamp that provides direct
4 illumination.

5 Other aspects and many of the attendant advantages will
6 be more readily appreciated as the same becomes better
7 understood by reference to the following detailed
8 description and considered in connection with the
9 accompanying drawing in which like reference symbols
10 designate like parts throughout the figures.

11 The features of the present invention which are
12 believed to be novel are set forth with particularity in the
13 appended claims.

14 BRIEF DESCRIPTION OF THE DRAWINGS

15 Fig. 1 is a perspective view of a dental video camera.

16 Fig. 2 is a side elevation in cross-section of a
17 fragmented distal portion of the dental video camera of Fig.
18 1 taken along the line 2-2 of Fig. 4.

1 Fig. 3 is a side elevation in cross-section of the
2 proximal portion of the dental video camera of Fig. 1 taken
3 along the line 3-3 of Fig. 4.

4 Fig. 4 is a top plan view in cross-section of the
5 fragmented distal portion of the dental video camera of Fig.
6 1 taken along the line 4-4 of Fig. 2.

7 Fig. 5 is a cross-sectional view of the fragmented
8 distal portion of the dental video camera of Fig. 1 taken
9 along the line 5-5 of Fig. 4.

10 Fig. 6 is a cross-sectional view of the dental video
11 camera of Fig. 1 taken along the line 6-6 of Fig. 2.

12 Fig. 7 is a cross-sectional view of the dental video
13 camera of Fig. 1 taken along the line 7-7 of Fig. 2.

14 Fig. 8 is a cross-sectional view of the dental video
15 camera of Fig. 1 taken along the line 8-8 of Fig. 3.

16 Fig. 9 is a cross-sectional view of a remote control
17 transmitter for use with the dental video camera of Fig. 1
18 taken along line 9-9 of Fig. 10.

1 Fig. 10 is a cross-sectional view of the remote control
2 transmitter of Fig. 9.

3 Fig. 11 is a side elevation in cross-section of a
4 fragmented distal portion of a dental video.

5 Fig. 12 is a cross-sectional view of the dental video
6 camera of Fig. 11 taken along the line 12-12 of Fig. 11.

7 Fig. 13 is a side elevation in cross-section of a
8 fragmented distal portion of a dental video camera.

9 Fig. 14 is a cross-sectional view of the dental video
10 camera of Fig. 13 taken along the line 14-14 of Fig. 13.

11 Fig. 15 is a cross-sectional view of the dental video
12 camera of Fig. 13 taken along the line 15-15 of Fig. 13.

13 Fig. 16 is a side elevation in cross-section of a
14 fragmented distal portion of a dental video camera.

15 Fig. 17 is a block diagram of an in vivo video camera
16 system that is constructed and operative in accordance with
17 U. S. Patent No. 5,604,531.

18 Fig. 18 is a schematic diagram of a video camera

1 capsule forming part of the in vivo video camera system of
2 Fig. 17.

3 Fig. 19 is a side elevation in cross-section of an
4 optical system within the distal portion of a dental video
5 camera with an adjustable iris.

6 Fig. 20 is a transverse view in cross-section of of the
7 distal portion of the dental video camera with the
8 adjustable iris of Fig. 19 when the knob has been rotated
9 clockwise forty-five degrees from the neutral position.

10 Fig. 21 is a side elevation in cross-section of the
11 mechanical system of the distal portion of the dental video
12 camera with the adjustable iris of Fig. 19 taken along line
13 21-21 of Fig. 20.

14 Fig. 22 is a side elevation in cross-section of a video
15 scope camera that is constructed and operative in accordance
16 with U. S. Patent No. 5,745,165.

17 Fig. 23 is a side elevation in cross-section of a video
18 scope camera that is constructed and operative in accordance

1 with U. S. Patent No.

2 Fig. 24 is a side elevation in cross-section of a hand-
3 piece that is constructed and operative in accordance with
4 U. S. Patent No. 5,908,294.

5 Fig. 25 is a partial, enlarged side elevation in cross-
6 section of the hand-piece of Fig. 24.

7 Fig. 26 is a partial, enlarged top plan view of the
8 hand-piece of Fig. 24.

9 Fig. 27 is a top plan view of a video scope that is
10 constructed and operative in accordance with U. S. Patent
11 No. 6,190,309.

12 Fig. 28 is a top plan view in cross-section of the
13 video scope of Fig. 27.

14 Fig. 29 is a side elevation in cross-section of the
15 video scope of Fig. 27

16 Fig. 30 is a partial, enlarged perspective view of the
17 video scope of Fig. 27.

18 Fig. 31 is a partial, enlarged side elevation of the

1 video scope of Fig. 27.

2 Fig. 32 is a top perspective view of a dental video
3 camera according to the present invention.

4 Fig. 33 is a bottom perspective view of the dental
5 video camera of Fig. 32.

6 Fig. 34 is a side elevation in cross-section of the
7 dental video camera of Fig. 32.

8 Fig. 35 is a top perspective view in cross-section of
9 the dental video camera of Fig. 32 that includes a focused
10 camera assembly with a charge coupled device and a cable
11 connector assembly.

12 Fig. 36 is a top plan view of the focused camera
13 assembly of Fig. 35 that includes an electrical circuit, a
14 focusing lens system and a flexible coupler that
15 electrically couples the electrical circuit to the charge
16 coupled device.

17 Fig. 37 is a side elevation of the focused camera
18 assembly of Fig. 35.

1 Fig. 38 is a side elevation of the focusing lens system
2 of Fig. 36 that includes a slidable portion and a fixed
3 portion.

4 Fig. 39 is an exploded perspective of the slidable
5 portion of the focusing lens system of Fig. 38.

6 Fig. 40 is an exploded perspective of the fixed portion
7 of the focusing lens system of Fig. 38.

8 Fig. 41 is a proximal elevation of the cable connector
9 assembly of Fig. 35.

10 Fig. 42 is a distal perspective view of the cable
11 connector assembly of Fig. 35.

12 Fig. 43 is a side elevation of the cable connector
13 assembly of Fig. 35.

14 Fig. 44 is an end elevation of a cable that
15 electrically couples to the cable connector assembly of Fig.
16 35.

17 Fig. 45 is a partial side elevation of the cable of
18 Fig. 44.

1 DESCRIPTION OF THE PREFERRED EMBODIMENTS

2 Referring to Fig. 1 in conjunction with Fig. 2 and Fig.
3 3 a dental video camera 10 includes housing 11, an optical
4 system 12 and a charge coupled device camera 13. The
5 housing 11 has an elongated cavity 14 that has a distal
6 portion and a proximal portion. The optical system 12 is
7 disposed in the distal portion of the elongated cavity 14 of
8 the housing 11. The charge coupled device camera 13 is
9 disposed in the proximal portion of the elongated cavity 14
10 of the housing 11. The optical system 12 includes an
11 adjustably focusing lens system 15, a penta-prism 16, a
12 fixed focusing lens system 17 and a sheath 18 which has an
13 optical window 19. The housing 11 has a distal end 20 and a
14 proximal end 21. The penta-prism 16 may be replaced with
15 another optical element that can deflect, deviate, invert or
16 rotate an image. The adjustably focusing lens system 15
17 includes a first sleeve 22, a first achromatic lens 23 and a
18 second achromatic lens 24. The adjustably focusing lens

1 system 15 may include only a single achromatic lens. A
2 singlet lens, a doublet lens or triplet lens may replace the
3 first achromatic lens 23. The first and second achromatic
4 lenses 23 and 24 are disposed in the first sleeve 22 and are
5 optically coupled to the charge coupled device camera 13.
6 The adjustably focusing lens system 15 is disposed within
7 the elongated cavity 14 of the housing 11 at the distal end
8 20.

9 Referring to Fig. 4 in conjunction with Fig. 5 and Fig.
10 6 the fixed focusing lens system 17 includes a second sleeve
11 25, a first micro-lens 26 and a second micro-lens 27. The
12 first and second micro-lenses 26 and 27 are disposed in the
13 second sleeve 25. The penta-prism 16 optically couples the
14 fixed focusing lens system 17 to the adjustably focusing
15 lens system 15. The elongated cavity 14 of the housing 11
16 has a bore 28 that is orthogonally disposed thereto at the
17 distal end 20 thereof. The fixed focusing lens system 17 is
18 disposed within the bore 28. The housing 11 further has

1 two parallel orthogonally disposed cavities 29 at its distal
2 end 20. The internal surfaces of the two parallel-
3 orthogonally disposed cavities 29 are either polished or
4 plated. They act as reflectors in order to direct heat
5 toward the optical window 19 of the sheath 18 in order to
6 defog the optical window 19 and minimize heat build-up
7 within housing 11 at the distal end 20. The dental video
8 camera 10 also includes two lamps 30 that are disposed in
9 the two inwardly angled, orthogonally disposed cavities 29
10 of the housing 11. The housing 11 dissipates heat from the
11 two lamps 30 that provide both direct illumination and anti-
12 fogging control through the optical window 19 of the sheath
13 18. The sheath 18 has a distal end 31, a proximal end 32
14 and an elongated cavity 33. The housing 11 is removably
15 inserted into the elongated cavity 33 of the sheath 18.

16 Referring to Fig. 2 in conjunction with Fig. 3 and Fig.
17 7 the adjustably focusing lens system 15 is optically
18 coupled to the charge coupled device camera 13. The penta-

1 prism 16 optically couples the fixed focusing lens system 17
2 to the adjustably focusing lens system 15. The optical
3 window 19 of the sheath 18 is optically aligned and
4 optically coupled to the fixed focusing lens system 17.

5 Referring to Fig. 3 in conjunction with Fig. 8 the
6 dental video camera 10 further includes a multiple-pin male
7 connector 34, a multiple-pin female connector 35, a cable 36
8 and external switches 37. The multiple-pin male connector
9 34 is electrically coupled to the multiple-pin female
10 connector 35. The multiple-pin female connector 35 is
11 electrically coupled to the cable 36. The cable 36 has a
12 plurality of wires which connect the external switches 37 to
13 a video processor, a recording device and a thermal printer
14 to the charge coupled device camera 13 and the two lamps 30
15 to a power source.

16 Referring to Fig. 9 in conjunction with Fig. 3 and Fig.
17 10 a dental video camera 110 includes a remote control
18 transmitter 111. The remote control transmitter 111 has a

multiple-pin female connector 112 and two batteries 113. The batteries 113 are either rechargeable or replaceable and are a source of power to the two lamps 30. The multiple-pin male connector 34 is electrically coupled to the multiple-pin female connector 112 of the remote control transmitter 111. A receiver remotely couples the thermal printer, the video processor and the recording device to the remote control transmitter 111 so that one of the external switches 37 controls each of the thermal printer, the video processor and the recording device.

Referring to Fig. 11 in conjunction with Fig. 12 a dental video camera 210 includes housing 211, an optical system 212 and a charge coupled device camera. The housing 211 has an elongated cavity 214 that has a distal portion and a proximal portion. The optical system 212 is disposed in the distal portion of the elongated cavity 214 of the housing 211. The charge coupled device camera is disposed in the proximal portion of the elongated cavity 214 of the

1 housing 211. The optical system 212 includes a adjustably
 2 focusing lens system 215, a penta-prism 216, a fixed
 3 focusing lens system 217 and a sheath 218 which has an
 4 optical window 219. The housing 211 has a distal end 220
 5 and a proximal end 221. The adjustably focusing lens
 6 system 215 includes a first sleeve 222, a first achromatic
 7 lens 223 and a second achromatic lens 224. A singlet lens,
 8 a doublet lens or a triplet lens may replace the first
 9 achromatic lens 223. The first and second achromatic
 10 lenses 223 and 224 are disposed in the first sleeve 222 and
 11 are optically coupled to the charge coupled device camera.
 12 The adjustably focusing lens system 215 is disposed within
 13 the elongated cavity 214 of the housing 211 at the distal
 14 end 220. The penta-prism 216 may be replaced with another
 15 optical element that can deflect, deviate, invert or rotate
 16 an image. The fixed focusing lens system 217 includes a
 17 gradient-indexed lens 225. The penta-prism 216 optically
 18 couples the fixed focusing lens system 217 to the adjustably

1 focusing lens system 215. The elongated cavity 214 of the
 2 housing 211 has a bore 226 that is orthogonally disposed
 3 thereto at the distal end 220 thereof. The fixed focusing
 4 lens system 217 is disposed within the bore 226. The
 5 housing 211 has two parallel, orthogonally disposed cavities
 6 227 at its distal end 220. The dental video camera 210
 7 also includes two lamps 228 that are disposed in the two
 8 parallel, orthogonally disposed cavities 229 of the housing
 9 211. The two lamps 228 provide direct illumination through
 10 the optical window 219 of the sheath 218. The sheath 218
 11 has a distal end 229, a proximal end and an elongated cavity
 12 230. The housing 211 is removably inserted into the
 13 elongated cavity 230 of the sheath 218. The adjustably
 14 focusing lens system 215 is optically coupled to the charge
 15 coupled device camera. The penta-prism 216 optically
 16 couples the fixed focusing lens system 217 to the adjustably
 17 focusing lens system 215. The optical window 219 of the
 18 sheath 218 is optically aligned and optically coupled to the

1 fixed focusing lens system 217.

2 Referring to Fig. 13 in conjunction with Fig. 14 and
3 Fig. 15 a dental video camera 310 includes housing 311, an
4 optical system 312 and a charge coupled device camera. The
5 housing 311 has an elongated cavity 314 that has a distal
6 portion and a proximal portion. The optical system 312 is
7 disposed in the distal portion of the elongated cavity 314
8 of the housing 311. The charge coupled device camera is
9 disposed in the proximal portion of the elongated cavity 314
10 of the housing 311. The optical system 312 includes a
11 adjustably focusing lens system 315, a fixed focusing lens
12 system 316 and a sheath 317 which has an optical window 318.
13 The housing 311 has a distal end 319 and a proximal end.
14 The adjustably focusing lens system 315 includes a first
15 sleeve 320, a first achromatic lens and a second achromatic
16 lens 321. A singlet lens, a doublet lens or a triplet lens
17 may replace the first achromatic lens. The first and second
18 achromatic lenses 321 are disposed in the first sleeve 320

1 and are optically coupled to the charge coupled device
2 camera. The adjustably focusing lens system 315 is disposed
3 within the elongated cavity 314 of the housing 311 at the
4 distal end 319. The fixed focusing lens system 316 includes
5 a second sleeve 322, a first micro-lens 323 and a second
6 micro-lens 324. The first and second micro-lenses 323 and
7 324 are disposed in the second sleeve 322. The fixed
8 focusing a lens system 316 is optically coupled to the
9 adjustably focusing lens system 315. The elongated cavity
10 314 of the housing 311 has a bore 325 that is axially
11 aligned therewith at the distal end 319 thereof. The fixed
12 focusing lens system 316 is disposed within the bore 325.
13 The housing 311 has two parallel cavities 326 disposed at
14 its distal end 319. The dental video camera 310 also
15 includes two lamps 327 and two bundles 328 of optical
16 fibers. Both bundles 328 of optical fibers are disposed in
17 the two parallel cavities 326 of the housing 311. The two
18 lamps 327 provide light to both of the bundles 328 of

1 optical fibers that provide direct illumination through the
 2 optical window 318 of the sheath 317. The sheath 317 has a
 3 distal end 329, a proximal end and an elongated cavity 330.

4 The housing 311 is removably inserted into the elongated
 5 cavity 330 of the sheath 317. The adjustably focusing lens
 6 system 315 is optically coupled to the charge coupled device
 7 camera. The fixed focusing lens system 316 is optically
 8 coupled to the adjustably focusing lens system 315. The
 9 optical window 318 of the sheath 317 is optically aligned
 10 and optically coupled to the fixed focusing lens system 316.

11 Referring to Fig. 16 a dental video camera 410 includes
 12 housing 411, an optical system 412 and a charge coupled
 13 device camera. The housing 411 has an elongated cavity 414
 14 that has a distal portion and a proximal portion. The
 15 optical system 412 is disposed in the distal portion of the
 16 elongated cavity 414 of the housing 411. The charge coupled
 17 device camera is disposed in the proximal portion of the
 18 elongated cavity 414 of the housing 411. The optical system

1 412 includes an adjustably focusing lens system 415, a fixed
2 focusing lens system 416 and a sheath 417 that has an
3 optical window 418. The housing 411 has a distal end 419
4 and a proximal end. The adjustably focusing lens system 415
5 includes a first sleeve 420, a first achromatic lens and a
6 second achromatic lens 421. A singlet lens, a doublet lens
7 or a triplet lens may replace the first achromatic lens.
8 The first and second achromatic lenses 421 are disposed in
9 the first sleeve 420 and are optically coupled to the charge
10 coupled device camera. The adjustably focusing lens system
11 415 is disposed within the elongated cavity 414 of the
12 housing 411 at the distal end 419. The fixed focusing lens
13 system 416 includes a gradient-indexed lens 422. The fixed
14 focusing lens system 416 is optically coupled to the
15 adjustably focusing lens system 415. The elongated cavity
16 414 of the housing 411 has a bore 423 that is axially
17 aligned therewith at the distal end 419 thereof. The fixed
18 focusing lens system 416 is disposed within the bore 423.

1 The housing 411 has two parallel cavities 424 disposed at
 2 its distal end 419. The dental video camera 410 includes
 3 two lamps 425 and two bundles 426 of optical fibers both of
 4 those are disposed in the two parallel cavities 424 of the
 5 housing 411. The two lamps 425 provide light to the bundles
 6 426 of optical fibers that provide direct illumination
 7 through the optical window 418 of the sheath 417. The
 8 sheath 417 has a distal end 427, a proximal end and an
 9 elongated cavity 428. The housing 411 is removably inserted
 10 into the elongated cavity 428 of the sheath 417. The
 11 adjustably focusing lens system 415 is optically coupled to
 12 the charge coupled device camera. The fixed focusing lens
 13 system 416 is optically coupled to the adjustably focusing
 14 lens system 415. The optical window 418 of the sheath 417
 15 is optically aligned and optically coupled to the fixed
 16 focusing lens system 416.

17 Referring to Fig. 17 an in vivo video camera system
 18 includes a swallowable capsule 510 for viewing inside the

1 digestive system and for transmitting at least video data, a
 2 reception system 512 located outside a patient and a data
 3 processor 514 for processing the video data. The data
 4 processor 514 operates two monitors, a position monitor 516
 5 on which the current location of the capsule 510 within the
 6 digestive system is displayed and an image monitor 518 on
 7 which the image currently viewed by the capsule 510 is
 8 displayed. The reception system 512 can either be portable,
 9 in which case, the data it receives is temporarily stored in
 10 a storage unit 519 prior to its processing in data processor
 11 514, or it can be stationary and close to the data processor
 12 514.

13 Referring to Fig. 18 in conjunction with Fig. 17 the
 14 capsule 510 includes a light source 520, a viewing window
 15 522, a camera system 524, an optical system 526, a
 16 transmitter 528 and a power source 530. The light source
 17 520 illuminates the inner portions of the digestive system
 18 through the camera system 524. The camera system 524 may be

1 a charge-coupled device (charge coupled device) camera and
2 detects the images. The optical system 526 focuses the
3 images onto the charge coupled device camera system 524.
4 The transmitter 528 transmits the video signal of the charge
5 coupled device camera system 524. The power source 530 may
6 be a battery and provides power to the entirety of
7 electrical elements of the capsule 510. The capsule 510 can
8 additionally include sensor elements for measuring pH,
9 temperature and pressure. A suitable small charge coupled
10 device camera system 524 is the 0.25" color charge coupled
11 device cameras of Sony Corporation of Japan. This single
12 chip includes the charge-coupled device and the electronics
13 for producing a video signal from the output of the charge
14 coupled device. The charge-coupled device can either
15 provide black and white signals or color signals. Because
16 it is desired to view the walls of the digestive tract, the
17 viewing window 522 typically is located on a side of the
18 capsule 510. The optical system 526 includes a mirror 527

1 and a focusing lens 529. The mirror 527 is a dichroic
2 mirror which transmits the light from the light source 520,
3 which may be a light emitting diode, to the walls of the
4 digestive tract via the viewing window 522. The mirror 527
5 deflects the light reflected from the digestive system
6 towards the focusing lens 529. The focusing lens 529
7 focuses the light onto the charge coupled device camera
8 system 524.

9 Referring to Fig. 19 in conjunction with Fig. 20 and
10 Fig. 21 the dental video camera 610 also includes an
11 adjustably focusing lens and charge coupled device camera
12 system 620 that is disposed within the proximal portion 613
13 of the housing 611. The adjustably focusing lens and charge
14 coupled device camera system 620 also includes a first
15 sleeve 625 and a second sleeve 626. The first sleeve 625 has
16 a longitudinal axis. The first sleeve 625 is axially
17 aligned along the longitudinal axis and is disposed within
18 the elongated cavity of the housing 611 adjacent to the

1 fixed focusing lens system 620. The first sleeve 625 is
 2 able to rotate about the longitudinal axis and is restrained
 3 from moving laterally back and forth along the longitudinal
 4 axis. The second sleeve 626 is telescopically and slidably
 5 coupled to the first sleeve 625. The second sleeve 626 is
 6 able to move laterally back and forth along the longitudinal
 7 axis and is restrained from rotating about the longitudinal
 8 axis. The knob 615 bi-directionally drives the second
 9 sleeve 626 laterally to produce back and forth lateral
 10 movements along the longitudinal axis. A slide mechanism
 11 may bi-directionally drives the second sleeve 626 laterally
 12 to produce back and forth lateral movements along the
 13 longitudinal axis. The back and forth lateral movements of
 14 the second sleeve 626 generate clockwise and counter-
 15 clockwise rotations, respectively, of the first sleeve 625.
 16 The adjustably focusing lens and charge coupled device
 17 camera system 620 also includes a first achromatic lens,
 18 which is disposed in a first lens carrier 627, and a second

1 achromatic lens, which is disposed in a second lens carrier
2 628. The first lens carrier 627 with the first achromatic
3 lens is disposed within and coupled to the first sleeve 625.
4 The second lens carrier 628 with the second achromatic lens
5 is disposed within the first sleeve 625 and is fixedly
6 coupled to the first sleeve 625. The adjustably focusing
7 lens and charge coupled device camera system 620 further
8 includes a spring 629. The spring 629 resiliently couples
9 the charge coupled device camera 621 to the elongated cavity
10 of the housing 611. The second sleeve 626 engages the
11 charge coupled device camera 621 and laterally moves the
12 charge coupled device camera 621 back and forth. The back
13 and forth lateral movements of the second sleeve 626 changes
14 the position of the charge coupled device camera 621 with
15 respect to the first and second achromatic lenses thereby
16 changing the field of focus. The adjustably focusing lens
17 and charge coupled device camera system 620 provides
18 a focusing adjustment between a near field of focus and a

1 far field of focus. The dental video camera 610 also
2 includes an adjustable iris 630 that is optically and
3 mechanically coupled to the adjustably focusing lens system
4 620. The adjustable iris 630 is adjusted between a nearly
5 closed opening and a wide open opening in response to the
6 focusing adjustment between the near field of focus and the
7 far field of focus. When the knob 615 is in the neutral
8 position the opening of the adjustable iris 630 is between
9 nearly closed and wide open.

10 Referring to Fig. 20 in conjunction with Fig. 21 when
11 the knob 615 has been rotated counter-clockwise forty-five
12 degrees from the neutral position the opening of the
13 adjustable iris 630 is wide open.

14 Referring to Fig. 22 an intra oral video camera 710
15 includes an insert portion 711 that is to be inserted into
16 the oral cavity of a patient, a grip 712 to be held by a
17 hand of an operator or a doctor, and a cover glass 713 of an
18 entrance window on which image light reflected from a

1 subject becomes incident. Provided in the vicinity of the
2 leading end of the insert portion 711 is an imaging system
3 that includes an objective lens 714, a charge coupled device
4 unit 715 and a prism mirror 716 for lateral vision. The
5 objective lens 714 includes a single lens having an aspheric
6 surface for aberration correction. An iris diaphragm with a
7 fixed aperture is provided between the objective lens 714
8 and the prism mirror 716. The objective lens 714 is fixed
9 while the charge coupled device unit 715 is movable. The
10 grip 712 is provided with a self-reset type pushbutton 717
11 adapted to reciprocate by means of a spring 717A, an
12 operation cycling mechanism 718 (intermittent rotation
13 mechanism) adapted to rotate $1/N$ of a full rotation in one
14 direction in response to one depression of the pushbutton
15 717, and an image pickup device moving mechanism 719 for
16 moving the charge coupled device unit 715 along the optical
17 path (direction indicated by an arrow P in the figure) as
18 given a predetermined amount of displacement by the

1 accommodates therein a light source 724 for illumination and
2 a light guide 725 for guiding light received from the light
3 source to the vicinity of the leading end of the insert
4 portion 812 so as to allow the light to exit therefrom.
5 The light guide 725 may be provided with a converging lens
6 726 or a diverging lens at the light-incident side or the
7 light-exit side thereof, respectively. An electric circuit
8 727 includes an image pickup signal circuit and light source
9 circuit that is provided within the grip 712. An electric
10 cable 728 transmits image pick up signals and supplies
11 electric power. Each time the operator depresses the
12 pushbutton 717, the distance between the objective lens 714
13 and the charge coupled device unit 715 varies so that the
14 imaging magnification can be instantaneously varied.
15 Depressing the pushbutton 717 N-times causes the imaging
16 magnification to resume its initial magnification. The
17 rotary cam 721 is of a shape resembles a square. Each side
18 $(1/4)$ of the circumference of the rotary cam 721 is formed

1 with a cam surface for changing the distance between the
2 objective lens 714 and the charge coupled device unit 715
3 correspondingly to three imaging magnification modes for
4 imaging one tooth, entire mouth and whole face which are
5 required of a video scope camera for use in dentistry. By
6 depressing the pushbutton 717, the magnification modes for
7 tooth, mouth and face can be selectively switched. The mode
8 cycle is completed at every third depression of the
9 pushbutton 717.

10 Referring to Fig. 23 a video-scope 810 that is for a
11 dental or oral use. The video-scope 810 includes an insert
12 portion 811 to enter an oral cavity, a grip portion 812 to
13 be held by an operator, two light windows 814 for
14 illuminating an object inside of the oral cavity, and an
15 acceptance window 813 for receiving reflected light from the
16 object are formed at the tip of the insert portion. These
17 windows are formed in the wider side-wall of the insert
18 portion that has an oblong profile. A prism 815 is disposed

1 in the tip of the insert portion 811 for directing the
2 reflected light from the object through the acceptance
3 window 813 to charge coupled device unit 817 that is
4 disposed in the tip of the insert portion 811 too. An
5 object lens 816 is disposed between the prism 815 and the
6 charge coupled device unit 817. An iris may be disposed
7 between the prism 815 and the object lens 816. The
8 reflected light rays from the object reach the charge
9 coupled device unit 817 through the acceptance window 813,
10 the prism 815 (and the iris) and the object lens 816. A
11 video circuit 818 is disposed in the grip portion. The video
12 circuit 818 is formed on a printed wiring board (PWB) that
13 extends from the inside of the grip portion to the inside of
14 the insert portion. The charge-coupled device unit 817 are
15 mounted on the distal end of the PWB of the video circuit
16 818. A light source 819 for illuminating the object is
17 disposed in the grip portion 812. Light rays emitted by the
18 light source 819 are directed to the direction of the insert

1 portion by a concave mirror 10 and enter each condensing
2 portion 11 of two light guides 14. Each light guide 14 has
3 the condensing portion 11, a guiding portion 12 and a
4 shedding portion 13. The light guide 14 can be made of a
5 transparent plastic such as an acrylic by molding. The
6 light rays that enter the condensing portion 11 of the light
7 guide 14 propagate in a guiding portion 12 and are shed from
8 the shedding portion 13 that is located adjacent to the
9 lighting windows 814. The condensing portion 11 of the
10 light guide 14 has a shape that is suitable for efficiently
11 condensing the light rays from the light source 819 and the
12 concave mirror 10 and giving them to the guiding portion 12
13 of the light guide 13. The guiding portion 12 has a thin
14 oblong profile so as to be disposed in a narrow space
15 between the prism 815, the object lens 816, or the charge
16 coupled device unit 817 and the side walls of the insert
17 portion 811. The distal end of the guiding portion 12 has a
18 reflection face angled at 45 degrees to direct the light

1 rays to the shedding portion 13. The video-scope 810 has a
2 battery 15 in the grip portion 812 for supplying a power to
3 the charge coupled device unit 817 and its drive circuit
4 817a, the video circuit 818 and the light source 819. An
5 alkaline battery, a lithium battery or a rechargeable
6 battery can be used interchangeably. A video output cable
7 16 extends from the proximal end of the grip portion 812 for
8 connection with a display such as a monitor TV set. The
9 light source 819 is a halogen lamp and can be exchanged
10 easily. The light source 819, the charge coupled device
11 unit 817, its drive circuit 817a and the video circuit 818
12 are turned on and off by switches that are arranged on the
13 grip portion. The video-scope 810 includes two light guides
14 made of a transparent plastic material having a condensing
15 portion, a guiding portion and a shedding portion.
16 Therefore this video-scope 810 can be assembled easily in a
17 low cost compared with that of the prior art while
18 maintaining a good quality image. In addition, since the

1 light rays propagate inside the light guide, the heat of the
2 light rays hardly influence the charge coupled device unit
3 and its drive circuit. The heat of the light rays also does
4 not influence the video circuit since the concave mirror
5 shields the video circuit from heat of the light rays.
6 Moreover, since the charge coupled device unit is disposed
7 in the tip of the insert portion, an optical fiber or other
8 means for transmitting the image from the object to the
9 charge coupled device unit can be eliminated without
10 deterioration of the image quality. Mounting the charge
11 coupled device unit, its drive circuit and the video circuit
12 on the single PWB facilitates assembling of the video-scope
13 as well as adjusting electric characteristics. The video-
14 scope is easy to handle since only a thin video cable is
15 extended from the proximal end of the grip portion and the
16 insert portion can be thin enough to move in the mouth
17 cavity.

18 Referring to Fig. 24 in conjunction with Fig. 25 and

1 incandescent light bulb, such as Gilway Technical Lamp #
 2 4115 or a "white light emitting diode". This white light
 3 emitting diode could include a short-wavelength LED combined
 4 together with a phosphorescent coating, such as Nichia
 5 America # NSCW-100. The "white light emitting diode" could
 6 also include a set of three single color light emitting
 7 diodes (e.g., red, green, and blue), mounted in a single
 8 package, such as Nichia America # NSCM-310. While two lamps
 9 are depicted in the figure, any number of lamps may be used.
 10 In addition to generating light, the lamps also generate
 11 some heat. This is advantageous in dental applications,
 12 because it helps clear away condensation that could form
 13 from a patient's breathing on a cold instrument. By
 14 locating the lamps in the distal end of the hand piece,
 15 distal to the imaging window, and angling the lamps so as to
 16 provide direct illumination of the object being imaged, the
 17 diameter of the housing can be minimized. This allows the
 18 hand piece to be contained within a slimmer housing, as

1 compared to other cameras which have light sources
2 positioned above the imaging window, such as the one
3 described in U. S. Patent No. 4,575,805. A slimmer device
4 is advantageous for dental use. Alternative light source
5 arrangements may also be used. The median section 912 of
6 the hand-piece 919, which houses the lens system 932, the
7 image sensor 933, and the focusing mechanism 913. The lens
8 system 932 is preferably a fixed-focus lens system. The
9 image sensor 933 is preferably either a charge coupled
10 device (charge coupled device) or an APS (active pixel
11 sensor array). The lens system 932 is located in the distal
12 portion of the median section 912, proximal to the distal
13 end of the hand-piece 911. The movable image sensor 933 is
14 located proximal to the fixed lens system 932. The lens
15 system 932 transmits the light arriving from the distal end
16 of the hand-piece 911 to the active surface of the image
17 sensor 933. The lens system 932 may be replaced by another
18 type of light direction means including, for example, a

1 mirror, a prism, and an optical fiber. The movable image
2 sensor 933 is controlled by a plunger system that is
3 attached to the focusing ring 913. The focusing ring 913
4 can be manually rotated into any of a plurality of detented
5 positions that correspond to a plurality of image sensor
6 positions.

7 Referring to Fig. 27 in conjunction with Fig. 28, Fig.
8 29, Fig. 30 and Fig. 31 a video scope 1010 includes an entry
9 section 1011 that is to advance into an oral cavity and a
10 grip section 1012 that is to be held by a hand of an
11 operator. A window of incidence 1013 that is made of a
12 light transmissive glass material, resin material or the
13 like is hermetically fixed to a side surface of the entry
14 section 1011 in the vicinity of a tip thereof, and an image
15 pickup system that consists of a prism mirror 1015 used as
16 an example of reflecting body for sideward observation, an
17 objective lens 1016 and a charge coupled device unit 1017 is
18 built in the tip of the entry section 1011. Illumination

1 windows 1014 for light projection are disposed on both sides
 2 of the window of incidence 1013 so that illumination rays
 3 emitted from surface mount type white light emitting diodes
 4 8 (Nichia Chemical Industries, Co., Ltd.) mounted on a
 5 substrate 8a are projected to the illumination windows 1014.
 6 The white light emitting diodes 1018 are arranged on both
 7 sides of the prism mirror 1015 and fixed in close contact
 8 with the illumination windows 1014. Top surfaces of the
 9 light emitting diodes 1018 are flush with a top surface of
 10 the prism mirror 1015. The illumination rays are projected
 11 directly to the illumination windows 1014 so that they are
 12 lost at a low ratio and used efficiently. Further, the
 13 white light emitting diodes 1018 are molded integrally with
 14 the illumination windows 1014 to reduce a number of required
 15 parts and simplify assembling procedures. The white light
 16 emitting diodes 1018 are used as a light source so that
 17 power consumption is lower than that of lamps. The white
 18 light emitting diodes 1018 have a long service life and

1 require no exchange with new ones. An iris diaphragm may be
 2 arranged between the objective lens 1016 and the prism
 3 mirror 1015. Disposed in the grip section 1012 are a camera
 4 circuit 1019 which operates the charge coupled device unit
 5 1017 and the white light emitting diodes 1018, and a power
 6 source 1020 which drives the camera circuit 1019 and the
 7 white light emitting diodes 1018. Built in the camera
 8 circuit 1019 are a voltage detection circuit which detects a
 9 voltage drop in the power source 1020 below a predetermined
 10 level, a flickering circuit which flickers the white light
 11 emitting diodes 1018 and a video output interception circuit
 12 which turns off a video output. While the power source 1020
 13 supplies a voltage at a sufficient level, the white light
 14 emitting diodes 1018 always stay lit so far as the video
 15 output is turned on. When the power source supplies a
 16 voltage lower than the predetermined level, however, the
 17 voltage detection circuit actuates and flickers the white
 18 light emitting diodes 1018 and turns off the video signals

1 with the video signal interception circuit. Usable as the
 2 power source 1020 is low voltage cells such as alkaline
 3 batteries, lithium cells or rechargeable cells. These cells
 4 are exchangeably mounted in a power source holder 1020a over
 5 which a watertight O-ring 1020b is fitted and the power
 6 source holder 1020a is set in the grip section 1012. A
 7 combination of a detachable cell pack and a charger may be
 8 used as the power source 1020. A video output cable 1021
 9 which is to be connected to a display such as a monitor TV
 10 is taken out of a rear portion of the grip section 1012. A
 11 section of this video output cable which ranges rearward
 12 from inside the grip section 1012 is made watertight. A
 13 reference numeral 1022 represents a switch that is water-
 14 tightly disposed on the grip section 1012 to facilitating to
 15 check teeth for tartar and decayed conditions.

16 Referring to Fig. 32 in conjunction with Fig. 33 and
 17 Fig. 34 a dental video camera 1110 includes housing 1111, an
 18 adjustably focusing lens and CCD camera system 1112, an iris

1 1113, a plurality of light emitting diodes 1114, a circuit
 2 board 1115 and video-processing circuitry 1116 and a
 3 flexible, electrical cable 1117. The housing 1111 has an
 4 elongated cavity with a distal end and a proximal end. The
 5 adjustably focusing lens and CCD camera system 1112 is
 6 disposed within the elongated cavity of the housing 1111.
 7 The adjustably focusing lens and CCD camera system 1112
 8 provides a focusing adjustment between a near field of focus
 9 and a far field of focus. The iris 1113 may be adjustable
 10 optically and is mechanically coupled to the adjustably
 11 focusing lens and CCD camera system 1112. The iris 1113, if
 12 adjustable, is a stretchable disc of material with a center
 13 pin-hole which slidable portion of the adjustably focusing
 14 lens and CCD camera system 1112 adjusts between a nearly
 15 closed opening and a wide open opening in response to the
 16 focusing adjustment between the near field of focus and the
 17 far field of focus. There may be a fixed focusing lens
 18 system optically which may be coupled to the adjustably

1 focusing lens and CCD camera system 1112 and which is
2 disposed in the elongated cavity of the housing 1111.

3 Referring to Fig. 36 in conjunction with Fig. 37 the
4 adjustably focusing lens and CCD camera system 1112 is a
5 focused camera assembly 1120 which includes a sleeve 1121, a
6 focusing lens system 1122 and a charge coupled device 1123.
7 The sleeve is slidably coupled to the housing 1111. The
8 focusing lens system 1122 and the charge-coupled device 1123
9 are disposed in the sleeve 1121. The charge-coupled device
10 1123 is electrically coupled to the circuit board 1115 and
11 the video-processing circuitry 1116 through the flexible,
12 electrical cable 1117. The focusing lens system 1122 is
13 carried on the front cover and focuses onto the imager an
14 image of an object in its field of view. The light emitting
15 diodes 1114 are carried on the head member and direct
16 illumination from the lamps into the field of view. The
17 electrical conduit carries power to the video processor
18 circuitry and to the light emitting diodes and carries from

1 the video processor circuitry a video signal that represents
2 the object in the field of view.

3 Referring to Fig. 38 in conjunction with Fig. 36, Fig.
4 39 and Fig. 40 the focusing lens system 1123 includes a
5 sleeve 1131, a lens carrier 1132, achromatic-lenses 1133
6 that are disposed in a slidable portion, fixed lenses 1134
7 that are disposed in a fixed portion and an iris 1135. The
8 sleeve 1131 is coupled to the housing 1111. The sleeve 1131
9 is able to move laterally back and forth. The lens carrier
10 1132 has achromatic lenses 1133 and fixed lenses 1134. The
11 sleeve 1131 engages the charge-coupled device so that the
12 sleeve 1131 laterally moves the charge coupled device back
13 and forth in order to change the position of the charge
14 coupled device with respect to the achromatic lenses 1133
15 and the fixed lenses 1134 thereby changing the field of
16 focus.

17 Referring to Fig. 41 in conjunction with Fig. 35, Fig.
18 41, Fig. 42 and Fig. 43 a cable connector assembly 1140

1 includes female connectors 1141 and a flexible circuit board
2 1142. The flexible circuit board 1142 is electrically
3 coupled to a circuit for the charge-coupled device 1143.

4 Referring to Fig. 44 in conjunction with Fig. 45 a
5 cable 1150 may be electrically coupled to the cable
6 connector assembly of Fig. 35.

7 From the foregoing it can be seen that a dental video
8 camera has been described. It should be noted that the
9 sketches are not drawn to scale and that distances of and
10 between the figures are not to be considered significant.

11 Accordingly it is intended that the foregoing
12 disclosure and showing made in the drawing shall be
13 considered only as an illustration of the principle of the
14 present invention.